Title:	Sturgeon and Stream Tables
Subject:	**Historical Changes in River Habitat for Atlantic Sturgeon (can Atlantic sturgeon once again reproduce successfully in the Merrimack River?)**
Author:	Rob Yeomans
Grade Level:	High School
Time Duration:	One 90 minute block or two 45 minute periods.
Overview:	Over the course of history, humans have changed the ecology of the natal rivers of Atlantic Sturgeon. Actions such as pollution and dam construction have drastically reduced the population in some rivers and extirpated other sturgeon populations. This lesson utilizes stream tables to illustrate the effects of dam construction on the ability of sturgeon to reproduce. Students are asked if rivers with impediments to migration such as dams, from which sturgeon have been extirpated, can once again have spawning fish if pollution is controlled, and young sturgeon are raised in conservation hatcheries and reintroduced into these rivers.
Objectives:	**Students will be able to:** • Illustrate how a stream/river is made • Describe the factors necessary for sturgeon to spawn • Build a model dam and explain its use • Discuss the environmental factors that change with the addition of a dam • Explain why, for certain rivers, the sturgeon population will remain extirpated.
Materials:	**For one demonstration table:** • Stream table • 12 volt battery • Circulating bilge pump (360gph) • Collection bucket • Hosing that fits the pump and is long enough to return water to start of table **For several student tables:** • Stream table • Lab tables long enough to hold stream tables • Hosing that fits lab table faucet • River bed material (granulated plastic) Composition Materials Inc. 125 Olgate Lane Milford, CT 06460 Phone: 800-262-7763 or 203-874-6500 Fax: 203-874-6505 Emai: info@compomat.com Attention: Doug Berkowitz • Rocks, sprigs of bushes • String, rulers, trowels • Dam building material • Toy houses and boats (monopoly pieces would work) • Easel paper and markers
Reference web sites	http://www.watersheds.org/earth/streamtable.htm (example) http://www.blm.gov/or/programs/nrst/files/stream_table.pdf or

	http://www.vaswcd.org/documents/cookbook/Cookbook%20Part%208%20Stream%20Table.pdf (how to build one) http://serc.carleton.edu/files/NAGTWorkshops/intro/activities/STREAM_TABLES.doc (calculations) http://geography.cst.cmich.edu/Franc1M/4geo105/exercises/Rivers/Stream%20Table%20Exercise%5B1%5D.doc.
Procedure:	**Pre Lab Discussion** 1. Ask students if they know of any ocean fish that lay their eggs in a river (salmon, herring). Introduce the term anadromous and that sturgeon are also in this category. Briefly discuss the life cycle of sturgeon and population before 1900. Sturgeon spawn: • Predominantly in the spring • above the salt front (0 salinity) • in fast moving currents • over a bottom substrate of cobble, rocks or gravel • in water temperatures of 13-18º Celsius • dissolved oxygen levels are high (due to relatively fast moving water) From Essential Spawning and Nursery Habitat of Atlantic Sturgeon (*Acipenser oxyrinchs*) in Virginia, Bushnoe et al. 2. Discuss the environmental changes that occur when traveling from ocean to river. How will these changes affect organisms moving into these areas from the ocean? • salinity decreases and finally there is a change to purely freshwater beyond the salt front, which results in changing the osmotic balance from one of hypertonic to one of hypotonic; anadromous fish can withstand these changes while other oceanic fish, like cod or haddock, cannot • dissolved oxygen decreases and this may be dangerous for organisms with gills if it is too low • temperature increases from the shallow water and further reduces the dissolved oxygen level • pollution from recreation, industry and coastal residential development increases • contact with man-made items like boats, docks and moorings increases 3. Discuss the reasons a dam would be built and the effects of dam construction on a river ecosystem **Lab Directions** **Part I. Creating and Running a natural stream.** 1. In groups of two, have the students collect the materials they will need to build their own stream. At their station, have them fill the table with 2" of granulated plastic. Use a ruler or trowel to shape the surface of the granulated plastic so it slopes upward toward the high end of the stream table (near the inflow sink). The low end of the stream table should be void of granulated plastic. Attach the hose to the faucet and put it in the upper end of the stream table. Make sure the lower end of the stream table will drain into the adjacent sink. 2. Put rocks, sprigs of bushes (represent trees) and houses into the "sand" at various points in the table.

3. Turn on the water slowly and make observations about the interaction of the water and sand.

- Does a stream form right away? Explain.
- When the steam has formed, does it flow in a straight line? What determines the path that the stream follows?
- Dra**w** a map of the stream table, showing the path that the stream follows. Include the items you placed in the sand.
- Draw an arrow on your drawing to indicate the direction of water flow
- On your drawing, indicate where erosion is occurring by writing an 'E,' and indicate where deposition is occurring by writing a 'D'

4. Determine the overall length of your stream using the string. Measurements should be in cm and noted in your map.

5. Determine the sinuosity of your stream (how curvy it is).

$$\text{Sinuosity (no units)} = \frac{\text{Straight distance (cm)}}{\text{Curvy distance (cm)}}$$

Make note of this in your map.

6. Determine the velocity of your stream by placing a piece of leaf at the start and timing how long it takes to get to the bottom. Use:

$$\text{Velocity} = \frac{\text{distance traveled (cm)}}{\text{time for travel (sec)}}$$

7. While running the stream, assume that the upper region of your stream table (10 cm from the edge of the table) is the natural environment for sturgeon to use for spawning (exception being the gravel bottom). Create a list on your map of the abiotic factors that fish will encounter.

Part II. Dam construction

8. Shut the water down. Using materials from the front bench, create a dam that will NOT stop water flow, but slow down water flow. Place the dam on your river half way from its origin. Make it at least as high as the river bank. Use small straws to connect the upriver portion of the stream to the down river portion of your stream. On your map, indicate the position of your dam.

9. Slowly turn on the water reaching the same discharge as part 1. Observe the river's interaction with your dam. On your map, near the site of your dam, note your observations concerning the upriver section and downriver section.

10. Determine the velocity of the water downstream from the dam, starting at the dam outlet. Indicate this on your map.

11. Determine how the abiotic factors have changed on both sides of the dam with the inclusion of the dam. Note these on your map.

	12. Shut down your stream and return all materials to the front bench. Allow the granulated plastic to dry.
Conclusion	**Homework** 1. Why is there not a vast array of locations in a river system that Atlantic sturgeon could use for spawning? 2. How would you expect water temperatures to change with the addition of a dam on the downriver section? How will this affect spawning sturgeon? 3. How would you expect dissolved oxygen to change with the addition of a dam on the downriver section? 4. Since fish cannot swim up to their spawning grounds due to the addition of a dam, people have created different means to allow fish to bypass the dam to get upstream. Research and explain both methods that are used. 5. Research the success of your answer to #4 on Atlantic sturgeon. What would you construct to aid sturgeon in their migration past a dam? 6. Determine if a river can have spawning populations of Atlantic sturgeon if: • The sturgeon population is extirpated • There is a dam in the migratory spawning path of sturgeon • The water quality is monitored and controlled to increase DO levels, decrease pollution levels and monitor temperature levels • A conservation hatchery raises 5,000 young sturgeon and releases them at a location below the dam every year for three years 7. Explain the effects of a dam being built that splits a sturgeon population two. One population is above the dam and has access to historic spawning areas but not foraging habitat. The other population is below the dam and has access to good foraging habitats but not spawning areas.